

Amendments to the Claims:

This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

1 - 26 (Cancelled)

27. (Currently Amended) A semiconductor structure, comprising:
- at least one contact pad provided on the surface of a said substrate;
 - a layer of passivation material deposited over the surface of said substrate, said layer of passivation material having at least one opening that aligns with said at least one contact pad;
 - at least one layer of seed material deposited over said layer of passivation material, the seed layer contacting a surface of the contact pad;
 - at least one layer of Under Bump Metal (UBM) ~~created~~ deposited over the surface of said layer of seed material;
 - at least one layer of solder material having a solder height provided over the surface of said at least one layer of UBM;
 - a layer of polymer material deposited ~~coated~~ over the layer of passivation material to a polymer thickness, said polymer thickness being less than said solder height ~~by a measurable amount~~, said polymer contacting said layer of solder material over a substantial portion of the thickness of the polymer layer; the polymer layer further having an opening aligned with the contact pad;
 - ~~said solder protruding from the surface of said layer of polymer by said measurable amount, said protrusion forming a protruding layer of solder; said protruding layer of solder having been reflowed, thereby having created a solder ball;~~
 - ~~wherein a height of said solder ball is dependent upon the thickness of said polymer layer~~
- wherein the solder layer is disposed within the opening in the polymer layer, the solder layer height being greater than the polymer layer thickness; the solder layer comprising a column portion having a substantially cylindrical shape with a first diameter and a bump portion having a second diameter, the bump portion further having a substantially spherical shape; and

wherein the column portion is disposed within the opening and has a height substantially equal to the polymer layer thickness, the bump portion extends above a top surface of the polymer layer thickness, and the first diameter is substantially smaller than the second diameter.

28. (Previously Presented) The semiconductor structure of claim 27, said at least one contact pad comprising aluminum or an aluminum alloy.
29. (Previously Presented) The semiconductor structure of claim 27, said at least one layer of UBM comprising a layer of nickel, created to a thickness between about 1 and 10 μm .
30. (Previously Presented) The semiconductor structure of claim 27, said at least one layer of UBM comprising a layer of chrome, followed by a layer of copper, followed by a layer of gold, created to a thickness between about 1 and 10 μm .
31. (Previously Presented) The semiconductor structure of claim 27, said at least one layer of UBM comprising multiple layers of metal.
32. (Currently Amended) The semiconductor structure of claim 27, ~~with additionally at least one layer of metal having been created by electroplating said at least one~~ wherein the layer of UBM is formed by electroplating.
33. (Previously Presented) The semiconductor structure of claim 27, wherein the layer of polymer comprises a polyimide.
34. (Currently Amended) A semiconductor structure comprising:
a semiconductor substrate having at least one contact pad;
a passivation layer provided on a surface of the substrate, the passivation layer
having at least one opening to expose at least a portion of the contact pad;
a seed layer provided over a portion of the passivation layer and the exposed
portion of the contact pad;
an Under Bump Metal (UBM) layer provided over the seed layer;
at least one layer of solder material provided over the UBM layer, the solder
material having a height;

a polymer layer provided over the passivation layer and surrounding said solder layer; said polymer contacting said layer of solder material over a substantial portion of the thickness of the polymer layer; the polymer layer having a thickness smaller than the solder material height; ~~said solder protruding from a top surface of said polymer layer by an amount sufficient to enable formation of a solder ball when said solder material is subjected to heat sufficient to reflow said solder material;~~ wherein the solder ball diameter is a function of the thickness of the polymer layer such that controlling the thickness of the polymer layer controls the diameter of the solder ball

wherein the layer of solder material comprises first and second portions, the first portion having a cylindrical shape with a height substantially equal to the thickness of the polymer layer, the second portion disposed above a top surface of the polymer layer and having a spherical shape with a diameter substantially greater than the diameter of the first portion.

35. (Currently Amended) The semiconductor structure of claim 34, wherein ~~etching~~ adjusting the thickness of the polymer layer adjusts the diameter of the second portion when said solder layer is subjected to a reflow temperature to a desired thickness prior to forming the solder ball controls the ball diameter.

36. (Currently Amended) The semiconductor structure of claim 35, wherein the second portion solder ball has a height, and wherein ~~adjusting~~ etching the thickness of the polymer layer to a desired thickness prior to forming the solder ball controls adjusts the ball height of the second portion when said solder layer is subjected to the reflow temperature.

37. (Previously Presented) The semiconductor structure of claim 34, wherein the polymer layer comprises a polyimide.

38. (Previously Presented) The semiconductor structure of claim 34, wherein said contact pad comprises aluminum or an aluminum alloy.

39. (Previously Presented) The semiconductor structure of claim 34, wherein said UBM layer comprises nickel having a thickness between about 1 and 10 μm .

40. (Previously Presented) The semiconductor structure of claim 34, wherein said UBM layer comprises multiple layers of metal.
41. (Previously Presented) The semiconductor structure of claim 34, wherein said UBM layer comprises a layer of chrome, followed by a layer of copper, followed by a layer of gold, having a total thickness between about 1 and 10 μm .
42. (New) The semiconductor structure of claim 27, wherein the polymer layer thickness is sufficient to prevent deformation of the UBM layer during thermal processing of the structure.
43. (New) The semiconductor structure of claim 42, wherein the thermal processing comprises applying a temperature to the structure sufficient to reflow the solder layer.
44. (New) The semiconductor structure of claim 34, wherein the polymer layer thickness is sufficient to prevent deformation of the UBM layer during thermal processing of the structure
45. (New) The semiconductor structure of claim 44, wherein the thermal processing comprises applying a temperature to the structure sufficient to reflow the solder layer.
46. (New) The semiconductor structure of claim 27, wherein the polymer layer comprises multiple individual coats of polymer material.

Rejections

35 U.S.C. §103(a)

Claims 27-28 and 30-38 and 40-41

Claims 27-28 and 30-38 and 40-41 stand rejected under 35 U.S.C. §103(a) as unpatentable over the Greer patent taken with the Scholz patent.

Claim 27 has been amended to recite, *inter alia*:

“A semiconductor structure, comprising ... at least one layer of solder material ... having a height ... a layer of polymer material deposited ... to a polymer thickness, said polymer thickness being less than said solder height; said polymer contacting said layer of solder material over a substantial portion of the thickness of the polymer layer; the polymer layer further having an opening ... wherein the solder layer is disposed within the opening ... the solder layer height being greater than the polymer layer thickness; the solder layer comprising a column portion having a substantially cylindrical shape with a first diameter and a bump portion having a second diameter, the bump portion further having a substantially spherical shape; wherein the column portion is disposed within the opening and has a height substantially equal to the polymer layer thickness, the bump portion extends above a top surface of the polymer layer thickness, and the first diameter is substantially smaller than the second diameter.”

Claim 34 has been amended to recite, *inter alia*:

“A semiconductor structure comprising ... at least one layer of solder material ... having a height; a polymer layer ... surrounding said solder layer; said polymer contacting said layer of solder material over a substantial portion of the thickness of the polymer layer; the polymer layer having a thickness smaller than the solder material height; wherein the layer of solder material comprises first and second portions, the first portion having a cylindrical shape with a height substantially equal to the thickness of the polymer layer, the second portion disposed above a top surface of the polymer layer and having a spherical shape with a diameter substantially greater than the diameter of the first portion.”

Claims 27 and 34 are patentable because the Greer and Scholz patents, taken either alone or in combination, fail to disclose, teach or suggest every limitation of the claims. Specifically, the Greer and Scholz patents fail to disclose, teach or suggest a “... layer of solder material ... the solder layer comprising a column portion having a substantially

cylindrical shape with a first diameter and a bump portion having a second diameter, the bump portion further having a substantially spherical shape; wherein the column portion is disposed within the opening and has a height substantially equal to the polymer layer thickness, the bump portion extends above a top surface of the polymer layer thickness, and the first diameter is substantially smaller than the second diameter,” as required by claim 27; or a “...layer of solder material ... having a height; a polymer layer ... surrounding said solder layer ... the polymer layer having a thickness smaller than the solder material height; wherein the layer of solder material comprises first and second portions, the first portion having a cylindrical shape with a height substantially equal to the thickness of the polymer layer, the second portion disposed above a top surface of the polymer layer and having a spherical shape with a diameter substantially greater than the diameter of the first portion,” as required by claim 34.

The Greer patent discloses a solder bump having a column portion and a spherical portion as shown in Figs. 3 and 6, however the cylindrical portion does not have a height substantially equal to the thickness of the polymer layer. (See the Greer patent, Figs. 3 and 6). The cylindrical portion instead is located below the polyimide (*i.e.* polymer) layer 302, 502, 706, (*see id.*, col. 4, line 31; col. 5, line 46; col. 7, line 9 and Figs. 3, 6, 7), and is instead located entirely within the passivation layer 302, 502, 704. (*Id.*)

The Scholz patent does not cure this deficiency, because it discloses a solder layer in which the cylindrical portion has a height *greater* than the height of the polymer layer. (emphasis added) (See the Scholz patent, Figs. 1 and 2.)

Thus, the Greer and Scholz patents, either alone or in combination, fail to disclose every limitation of claims 27 or 34, and therefore applicants request that the 35 U.S.C. §103(a) rejections of claims 27 and 34 be withdrawn and that these claims be allowed. With respect to claims 28, 30-33, 35-38, 40 and 41, which depend from claims 27 and 34, respectively, and which recite additional features of the invention, applicants request that the 35 U.S.C. § 103(a) rejection of these claims be withdrawn for the same reasons as stated for claims 27 and 34, and that these claims likewise be allowed.

Claims 27, 28, 31, 33-38 and 40

Claims 27, 28, 31, 33-38 and 40 stand rejected under 35 U.S.C. 103(a) as unpatentable over the Tsuboi patent taken with the Scholz patent.

Independent claims 27 and 34 have been amended as noted above. These claims are patentable because the Tsuboi patent and the Scholz patent, taken either alone or in combination, fail to disclose, teach or suggest every limitation of the claims. Specifically, the Tsuboi and Scholz patents do not disclose, teach or suggest a "... layer of solder material ... the solder layer comprising a column portion having a substantially cylindrical shape with a first diameter and a bump portion having a second diameter, the bump portion further having a substantially spherical shape; wherein the column portion is disposed within the opening and has a height substantially equal to the polymer layer thickness, the bump portion extends above a top surface of the polymer layer thickness, and the first diameter is substantially smaller than the second diameter," as required by claim 27; or a "...layer of solder material ... having a height; a polymer layer ... surrounding said solder layer ... the polymer layer having a thickness smaller than the solder material height; wherein the layer of solder material comprises first and second portions, the first portion having a cylindrical shape with a height substantially equal to the thickness of the polymer layer, the second portion disposed above a top surface of the polymer layer and having a spherical shape with a diameter substantially greater than the diameter of the first portion," as required by claim 34.

The Tsuboi patent discloses a solder layer whose shape adjacent to the polymer layer is octagonal rather than a cylindrical (bottom portion of solder ball 24, *see* the Tsuboi patent, col. 7, lines 10-24, and Figs. 9, 10). The Scholz patent does not cure this deficiency, because as previously noted, it discloses a solder layer in which the cylindrical portion has a height *greater* than the height of the polymer layer. (emphasis added) (*See* the Scholz patent, Figs. 1 and 2).

Thus, the Tsuboi and Scholz patents, taken either alone or in combination, fail to disclose, teach or suggest every limitation of claims 27 or 34, and therefore applicants request that the 35 U.S.C. §103(a) rejections of claims 27 and 34 in light of these references be withdrawn and these claims be allowed.

With respect to claims 28, 31 and 33, and 35-38 and 40, which depend from claims 27 and 34, respectively, and which recite additional features of the invention, applicants request that the 35 U.S.C. §103(a) rejection of these claims be withdrawn for the same reasons as stated for claims 27 and 34, and that these claims likewise be allowed.

Claims 29 and 39

Claims 29 and 39 stand rejected under 35 U.S.C. 103(a) as unpatentable over the Greer and Scholz patents and further in view of the Moyer patent.

Claims 29 and 38 depend from independent claims 27 and 34, respectively, and recite additional features of the invention. As stated above, the Greer and Scholz patents, taken either alone or in combination, fail to disclose teach or suggest every limitation of independent claims 27 and 34. Specifically, the Greer and Scholz patents fail to disclose, teach or suggest a "... layer of solder material ... the solder layer comprising a column portion having a substantially cylindrical shape with a first diameter and a bump portion having a second diameter, the bump portion further having a substantially spherical shape; wherein the column portion is disposed within the opening and has a height substantially equal to the polymer layer thickness, the bump portion extends above a top surface of the polymer layer thickness, and the first diameter is substantially smaller than the second diameter," as required by claim 27; or a "...layer of solder material ... having a height; a polymer layer ... surrounding said solder layer ... the polymer layer having a thickness smaller than the solder material height; wherein the layer of solder material comprises first and second portions, the first portion having a cylindrical shape with a height substantially equal to the thickness of the polymer layer, the second portion disposed above a top surface of the polymer layer and having a spherical shape with a diameter substantially greater than the diameter of the first portion," as required by claim 34.

The Moyer patent does not cure this deficiency, but rather discloses a cylindrical portion (lower part of bump 310, 606) having a height substantially *smaller* than the thickness of polymer layer 302, 502. (See the Moyer patent, Figs. 3 and 6).

Thus, the Greer, Scholz and Moyer patents, taken alone or in combination, fail to disclose every limitation of claims 27 and 34. Thus, applicants request that the 35 U.S.C. §102(e) rejections of claims 29 and 39, which depend from claims 27 and 34, respectively, be withdrawn and that these claims be allowed.

In view of the foregoing amendments and remarks, Applicant submits that this application is in condition for allowance. Early notification to that effect is respectfully requested.

No fees are deemed due with this response, however , should any fees be required, the Commissioner for Patents is hereby authorized to charge any such required fees to deposit account 50-2061.

Respectfully submitted,

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